REPORT OF THE

ARS

FORAGE GRASS AND PASTURE WORKSHOP

Raleigh, North Carolina
April 30 - May 1, 1991

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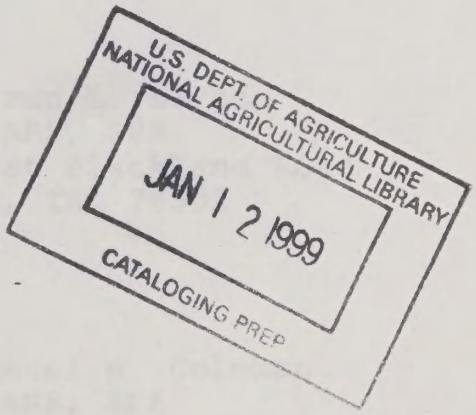

Compiled by
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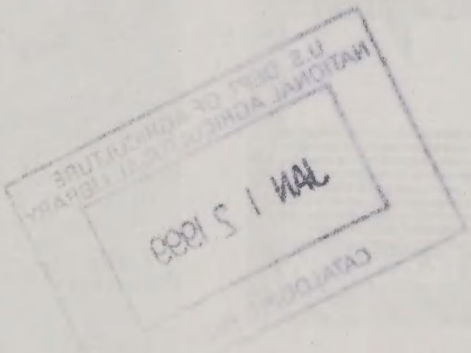
September 4, 1991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Raleigh, NC - April 30 - May 1, 1991

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Schedule of ARS Forage Grass and Pasture Workshop - 4/30-5/1/91

Raleigh, NC

Tuesday, April 30, 1991

8:00 - 9:30 AM - Introductions and disscussion of purpose of workshop.

Overview of present forage grass and pasture research effort

Assign 5 "discipline" discussion workgroups

1) Cool Season Grasses
2) Warm Season Grasses
3) Grass Physiology/Pathology
4) Pature Management
5) Pasture Utilization

9:30 - 11:30 - In discipline workgroups, identify research needs.

11:30 - 12:30 - Work group reports (copy of reports made available to afternoon workgroups.)

12:30 - 1:15 Lunch

1:15 - 3:30 - Form new workgroups across disciplines and with list of research needs identified above determine:

What research should ARS do?
(Note: Your workgroup can add research needs to list)
What is its priority?
What expertise does ARS presently have to do the research?
What additional expertise is needed?
Where should the research be conducted?

3:30 - 5:00 Report from workgroups and develop broad program areas

6:00 - ? Evening free

Wednesday, May 1, 1991

8:00 - 9:30 AM Discuss workgroup reports from previous day - Develop broad problem areas and reach consensus on priority needs, present expertise, etc.

11:00 - 12:00 Evaluation of the review process and discussion on appropriate interactions with constituents

12 Noon Adjourn workshop

Note:

1:00 - 5:00 PM Group recorders were asked to stay for the afternoon to draft workshop report (Plan of ARS Forage Grass and Pasture Research for the 1990's)

Discipline Groups for the Forage Grass and Pasture Workshop

Raleigh, NC 4/30-5/1/91

Discipline Groups in AM

Genetics				
Cool Season	Warm Season	Physiology/ Pathology	Pasture Management	Pasture Utilization
Eizenga	Hanna	Tischler	Moore	Tharel
Asay (R)	Voigt (R)	Johnson	Wilkinson (L)	Jung (R)
Jones	Burson	Frank	Stout	Hammond
Berdahl	Vogel (L)	West (L)	Belesky (R)	Williams (L)
Barker (L)	Dewald	Fisher (R)	Frere	Fairbrother
Berg	Burton	Wilson	Gates	Burns
Elgin	Sherwood	Welty	Rao	Coleman
			Brink	Stuedemann

Mixed Discipline Groups in PM

1	2	3	4
Voigt (R)	Tischler	Johnson (L)	Asay (R)
Jones	Wilson	Moore	Sherwood
Burton	Vogel	Hanna	Burson
Frank	Eizenga	Berdahl	West
Berg	Dewald (L)	Welty	Barker
Belesky (L)	Stout	Wilkinson	Frere (L)
Tharel	Stuedemann	Burns	Gates
Coleman	Hammond	Williams	Brink
Elgin	Fisher (R)	Jung (R)	Rao
Fairbrother			

(L) = Leader for Group
(R) = Recorder for Group

Forage Grass and Pasture Workshop Report - May 1991

A) Purpose of Workshop

The purpose of the forage grass and pasture workshop was to develop a plan for forage grass and pasture research in ARS-USDA for the coming decade and beyond. This plan is to delineate ARS program goals, thus charting a course for program direction and supporting funding requests. Without such a plan there will be a growing sense of research fragmentation and non-direction. Although attendance at the workshop was not mandatory, almost all invitees were in attendance. Wayne Hanna (Tifton, GA) and Joe Burns (Raleigh, NC) served as hosts. The workshop was held in Williams Hall on the North Carolina State University campus.

It was the intent of the workshop to have developed at its ending a document that included:

1) Status of ARS research at present,
2) Prioritized research needs for forage grass and pasture,
3) What part of the research needs ARS will address,
4) What expertise does ARS presently have to meet those needs,
5) What additional expertise is needed,
6) Where will the ARS research be conducted (locations).

The following sections constitute that report.

B) Background and current programs:

Cool-Season Grasses (Genetics):

ARS is conducting genetic research on cool-season forage grasses at 7 locations.

At Lexington, KY, 2 scientists (G. C. Eizenga and a vacant position) are working with tall fescue and *Festuca*-*Lolium* hybrids. Major breeding objective is to improve forage quality, especially during the summer months. Research emphasizes interactions between the host plant and endophyte (*Acremonium coenophialum*); in vitro doubling techniques, androgenic haploids, transmission of isozyme loci, N- and C-banding, and in situ hybridization.

At Mandan, ND, 6 scientists (A. B. Frank, J. D. Berdahl, J. F. Karn, J. M. Krupinsky, L. Hofmann, and R. E. Ries) and two university scientists (I. M. Ray and S. T. Dara) are working with Russian wildrye, intermediate wheatgrass, crested wheatgrass, and western wheatgrass. Research objectives include development of breeding procedures and selection criteria for improving forage yield and quality, disease resistance, and tolerance to environmental stress.

At Corvallis, OR, 9 scientists (R. E. Barker, S. M. Griffith, R. E. Welty, J. J. Steiner, J. A. Kamm, S. Alderman, G. M. Barwetz, G. W. Mueller-Warrent, and L. Elliott) are working with seed-production problems in cool-season grasses. Major objectives include evaluation and enhancement of grasses for seed production potential; studies of

reproductive tiller development, disease assessment and control, inheritance of disease resistance and herbicide tolerance, and genotype X environment interactions for characters relating to seed production; and application of biotechnological procedures to evaluate variation in cool-season grasses.

At Lincoln, NE 2 scientists (K. P. Vogel and K. J. Moore)conduct genetic research with cool-season grasses. Genetic and breeding programs are underway with smooth bromegrass and intermediate wheatgrass, and evaluation work is being done with crested wheatgrass. Objectives include genetic improvement in traits associated with forage quality, forage yield, and establishment vigor. Supporting research involves inheritance of quantitative traits, morphological development, effect of morphological development on seasonal distribution and forage quality, and improved criteria to evaluate forage quality in perennial grasses.

At University Park, PA 4 scientists (C. C. Berg, R. T. Sherwood, G. A. Jung, and W. L. Stout) are working with smooth bromegrass, orchardgrass, and perennial ryegrass . Genetics and breeding objectives include disease resistance, agronomic performance, and forage quality. Supporting research is underway relating to inheritance of quantitative traits, genetics of apomixis, evaluation for forage quality, and nitrogen utilization.

At Logan, UT, 8 scientists (N. J. Chatterton, T. A Jones, K. B. Jensen, R. Wang, D. A. Johnson, G. D. Griffin, J. H. Bennett, and K. H. Asay) are working with wheatgrasses, wildryes, Indian ricegrass, and several interspecific hybrids. Genetic and breeding objectives include resistance to biological and environmental stress, stand establishment vigor, agronomic performance, forage quality, and improved seasonal distribution of growth. Supporting research emphasizes carbohydrate metabolism, water-use efficiency and drought response, genome relationships, molecular biology, and development of improved breeding methods.

At Woodward, OK, 1 scientist (Dewald) is working on population improvement of Texas bluegrass (Poa arachinfera) accessions for disease resistance, forage and seed yields, persistence under stress and improved seasonal distribution of growth.

Warm-Season Grasses (Genetics):

ARS is conducting genetic research on warm-season forage grass at 7 locations.

At Tifton, GA, 3 scientists (Burton, Hanna, and Wilson) work primarily on bermudagrass, bahiagrass, and pearl millet. Research emphasizes apomixis - its transfer, inheritance and use; development of efficient breeding techniques; use of wild germplasm; improvement of forage yield and quality (bermudagrass and bahiagrass) and forage and grain yield (pearl millet); and cytogenetics and genetics of warm season grasses.

At College Station, TX, 1 scientist (Bashaw) works primarily on buffelgrass and Pennisetum sp. The research thrust is the study of apomixis, its inheritance and use; and increasing the winter hardiness and range of adaptation of buffelgrass.

At Temple, TX, 4 scientists (Burson, Tischler, Voigt, and Young) work primarily on lovegrass, switchgrass, dallisgrass, kleingrass, big bluestem, and eastern gamagrass. Research thrusts include apomixis mechanisms, transfer, inheritance, and use; phylogenetics, evaluation and development of improved germplasm; forage yield and quality; abiotic stress resistance; seedling establishment; and seed shattering resistance.

At Woodward, OK, 4 scientists (Dewald, White, Berg, and Sims) conduct research on big bluestem, old world bluestems and eastern gamagrass. Research emphasizes hybridization, evaluation, and selection of superior cultivars and strains with drought and soil toxicity tolerance.

At Lincoln, NE, 2 scientists (Vogel and Moore) conduct research on big bluestem and switchgrass. Research emphasizes development of random mating populations for forage yield and quality and testing and evaluation of those populations under grazing.

At University Park, PA, 3 scientists (Sherwood, Berg, Gustine) conduct research on buffelgrass, orchardgrass, and smooth bromegrass. The objective in buffelgrass is to determine the genetic and physiological basis of apomixis; in orchardgrass and smooth bromegrass to improve yield and resistance to foliar diseases.

At Mandan, ND, 3 scientists (Berdahl, Karn, and Ries) conduct research on blue grama grass. Research emphasizes improvement in seedling vigor, forage quality, and forage yield.

Forage Grass Physiology and Pathology:

ARS is conducting research in the physiology or pathology of forage grasses at 10 locations.

At Corvallis, OR, 5 scientists (Welty, Griffith, Mueller-Warrant, Alderman, and Kamm) conduct research on stem rust resistance of forage and turf cultivars of ryegrass and tall fescue grown for seed, the regulation of nitrogen use and rooting characteristics in forage and turf cultivars of ryegrass and tall fescue grown for seed, weed control in forage crops and turfgrasses grown for seed production, the epidemiology and control of blind seed and ergot in grasses grown for seed, and the biology and behavioral processes of forage legume and grass pests of seed production.

At Gainesville, FL, 1 scientist (West) is using a molecular approach to study the mechanism of adaptation and response to low temperature in subtropical grasses. He is also using tissue culture to select for heat tolerance in temperate grass species.

At Logan, UT, 2 scientists (Johnson and Chatterton) are working to determine the physiological bases of resistance to environmental and biological stresses; develop selection techniques and indices for screening grass and legume populations for resistance to environmental stresses, especially drought stress in crested wheatgrass and Russian wildrye; and determine the relationship of fructan composition and structure to cool-temperature growth in temperate grasses.

At Madison, WI, 5 scientists (Ralph, Mertens, Hatfield, Weimer, Satter) are directed at the chemical nature and structure of plant cell wall composition.

At Mandan, ND, 3 scientists (Frank, Krupinsky, and Ries) are conducting research to determine the relationships between drought tolerance mechinisms and growing degree days (phenological relationships in improvement and management of cool season grasses), the inheritance and resistance mechanisms of leaf and root diseases, seedling establishment mechanisms, and seedling morphology.

At Raleigh, NC, 1 scientist (Fisher) is studying morphological and physiological adaptations to the effects of defoliation in pastures. For example, readaptation to high light is being studied in leaves of subtropical grasses following partial defoliation.

At Temple, TX, 1 scientist (Tischler) is characterizing morphological structures and characteristics responsible for poor seedling establishment in warm-season forage grasses (Panicum, Paspalum, Eragrostis, Bouteloua, Andropogon, and Dichantheium) and developing techniques to select for variation in these characteristics. He is also studying selection for heat tolerance in Eragrostis, Panicum, Paspalum, and Tripsacum and selection for drought tolerance in Eragrostis.

At Tifton, GA, 1 scientist (Wilson) is screening for resistance to foliar blights, rust, and smut in pearl millet. In addition he is developing methods to select for resistance of pearl millet and bermudagrass to soil-borne pathogens and studying management of ergot in dallisgrass and bahiagrass.

At University Park, PA, 3 scientists (Sherwood, Berg, and Gustine) are determining the genetic and physiological basis of apomixis.

At Woodward, OK, 3 scientists (Dougherty, Bradford, and Sims) are developing and testing a simulation model for prediction responses of range plants, including several warm-season grasses, to environmental variation.

Pasture Management:

Pasture and forage management research is being conducted at 17 ARS locations, primarily east of the U.S. continental divide. Research programs integrate efforts in a range of disciplines to investigate the effects of soil, climate, and biological resources on pasture and forage management, and introduce new plant species and develop management regimes to improve quality, supply, and persistence of forage for the ruminant. Current ARS research activities in pasture and forage management include:

At Booneville, AR, 3 scientists (Tharel, Springer, Brown) are developing low-input animal production systems for hill-land small farms (including study of animal and environment interactions) and forage pest control (including plant disease and nematodes).

At Brooksville, FL, 2 scientists (Williams and Hammond) are developing methods to optimize utilization of subtropically adapted annual and perennial pasture legumes in animal production systems and studying animal response to pasture systems. The researach includes the evalutaion of introductions of new tropical pasture grasses.

At Watkinsville, GA, 3 scientists (Wilkinson, Frere, and Stuedemann) are studying new plant materials to increase the plant resources available

for use in animal production systems in the Southeast, to determine the effects of soil and nutrient input on forage persistence and animal performance, and to evaluate existing forage models and improve or modify them with new data.

At Beltsville, MD, 1 scientist (Drea) is developing biocontrol methods for purple loosestrife, spurge, thistle, and knapweed.

At East Lansing, MI, 1 scientist (Rotz) is developing and validating forage-based dairy systems model to improve profitability.

At St. Paul, MN, 1 scientist (Russelle) is studying the introduction, cycling, and loss of biologically fixed dinitrogen in soil plant systems, emphasizing aspects of groundwater quality, and developing models of legume nutrient use and study genetic and environment interaction effects upon forage quality.

At Mississippi State, MS, 4 scientists (Brink, Rowe, Fairbrother, and Pederson) are studying effects of grazing upon dinitrogen fixation and legume quality and persistence in Southeastern pasture systems. In addition, they are studying climatic and biotic factors affecting annual legume germination.

At Sidney, MT, 2 scientists (Asse and Tanaka) are developing forage systems to optimize water use and improve water quality through runoff and erosion control. They are also developing economical, ecologically sound weed control methods, including cropping sequences.

At Raleigh, NC, 1 scientist (Burns) is evaluating subtropical grasses under grazing for physiological responses for use in year-round grazing systems.

At Lincoln, NE, 1 scientist (Masters) is developing systems to restore tall grass and mixed grass prairie communities, emphasizing weed control and establishment techniques on highly erodible and marginal land.

At Mandan, ND, 4 scientists (Frank, Hoffmann, Ries, and Karn) are quantifying forage plant responses to grazed environments, including aspects of establishment, persistence, and animal production. This include the study of mixed prairie grassland response to global change and the carbon-nitrogen balance of prairie soils.

At Coshocton, OH, 3 scientists (Edwards, Owens, and Shipitalo) are studying management of water and nutrient movement in grazed and cropped systems, including study of the movement of herbicides and nitrates to groundwater.

At El Reno, OK, 4 scientists (Coleman, Hart, Phillips, and Mowrey) are developing forage-based systems for grazing animal production by investigating plant response to grazing; introducing new species to optimize utilization of climatic resources; studying plant morphology and resultant quality, including <u>in vivo</u> animal response studies; and developing analytical techniques to determine forage quality.

At University Park, PA, 3 scientists (Rogawski, Stout, and Schnabel) are quantifying soil effects upon nitrogen- and water-use efficiency and nitrogen movement in soil systems, developing rhizosphere and plant growth models for use in watershed model systems, and developing methodology to assess spatial and temporal soil variability.

At College Station, TX, 1 scientist (Bovey) is investigating factors associated with weed and brush control (including herbicide application, retention and effectiveness, physiological and environmental factors affecting absorption, and trans-location) and determining methods which preserve groundwater quality.

At Beckley, WV, 5 scientists (Belesky, Denison, Feldhake, Boyer, and Pasquarell) are developing low-input, forage-based animal production systems by improving seasonal distribution of forage through plant material selection and defoliation management. They are also investigating physiological responses of cool-season grasses and legumes to management schemes, investigating the use of adapted warm-season grasses in animal production systems, determining animal response. Investigate water and energy partitioning in hill-land pasture environments, and identifying legumes capable of persistence in hill-land environments.

At Woodward, OK, 1 scientist (Dewald) is improving technology to establish grasses rapidly and inexpensively on marginal farmland, optimize N fertilizer use efficiency and develop grazing systems for complementary use of eastern gamagrass and Old World Bluestem.

Pasture Utilization:

ARS is conducting pasture utilization research at 11 locations.

At Brooksville, FL, three scientists (Hammond, Williams, and Chase) research the influences of different bahiagrass grazing systems (rotational versus intensive continuous), winter supplementation, and cattle breed, on age, weight and body composition of heifers at puberty. Intensive continuous and rotational grazing systems are being evaluated, including studies of effects of pasture management on parasite transmission. Research is also focused on the utilization of Pennisetum hybrids and 'Rhizoma' perennial peanut in grazing systems.

At Tifton, GA, four scientists (Burton, Gates, Hanna, and Wilson) conduct research to evaluate genotypes of bermudagrass, pearl millet, bahiagrass, and other warm-season forages to identify superior forage quality characteristics and conduct grazing trials to evaluate improved bermudagrasses, bahiagrasses, and tall fescue/warm-season grass mixtures. Relationships between plant genotype, forage availability and animal performance are examined.

At Watkinsville, GA, 3 scientists (Stuedemann, Frere, and Wilkinson) are conducting grazing trials to determine the cause and effect relationships associated with fescue toxicosis in cattle, develop alternative mechanisms for overcoming fescue toxicosis, including development of ameliorating medications; and determine if cattle grazing toxic fescue are more susceptible to internal parasites than cattle grazing endophyte-free fescue. They are also determining defoliation patterns of cattle grazing alfalfa/tall fescue mixtures or monocultures, the effects of N source (inorganic, poultry litter, legume) and grazing intensities on performance of beef cattle grazing bermudagrass pastures, and the determination of nitrogen use efficiency of these N sources in grazed ecosystems.

At Mississippi State, MS, two scientists (Brink and Fairbrother) conduct pasture utilization studies which include effects of by-pass protein supplementation of ruminants grazing warm-season grasses on intake and liveweight gain; forage availability and grazing pressure effects on reseeding of cool-season annual, persistence of perennial legumes, and performance of grazing animals; and evaluation of morphological characteristics of white clover and persistence in warm-season grass pastures.

At Booneville, AR, three scientists (Brown, Tharel, Springer) are conducting pasture studies to determine beef cattle genotype (Angus, Brahman, and reciprocal crosses) x forage species (bermudagrass, fescue) interactions on preweaning performance, milk production, and blood serum cholesterol and amylase concentration in cooperation with scientists (Tolley and Nutting) at the Univ TN Medical School. The grazing trials also include studies of horn fly on animal performance in cooperation with a Univ AR scientist (Steelman). Additionally, beef cattle breed effects on animal performance under rotational and continuous grazing of bermudagrass or tall fescue are being assessed.

At El Reno, OK, six scientists (Phillips, Coleman, Hart, Volesky, Rao, and Mowrey) conduct research to evaluate the economics of producing beef on old world bluestem, bermudagrass, and native pasture, and of energy supplementation of lambs on pasture; compare N-fertilized old world bluestem pastures with those interseeded with legumes (red clover, sainfoin, rose clover); evaluate a frontal grazing system; and research the use of Brassica crops to fill gaps in the warm-season perennial grass system.

At Raleigh, NC, 2 scientists (Burns and Fisher) are researching relationships among herbage mass, canopy structure, diet characteristics and performance of grazing animals, relationships among diet characteristics and digestion kinetics of grazing or stall-fed animals; sugar and phenolic monomers of subtropical grass species with reference to forage quality; tiller growth and photosynthetic efficiency of subtropical grasses grazed at varying herbage mass; and the integration of herbage mass, canopy structure, diet characteristics and digestion kinetics through mathematical modeling to predict animal intake and performance on pasture.

At University Park, PA, 1 scientist (Jung) conducts utilization studies in cooperation with animal scientists at Penn State Univ (Harpster) and WV Univ (Reid) to determine the influence of maturation of big bluestem, switchgrass, and orchardgrass on voluntary consumption, digestibility, and rate of passage with beef cattle and sheep; the comparative utilization of warm- and cool-season forages by cattle, sheep and goats; and the relationships of digestion kinetics to cell wall constituents of parenchyma and sclerechyma isolated from orchardgrass and switchgrass. They are also researching the use of endophyte-free tall fescue cultivars in rotational grazing with ewes and lambs; and the use of Brassica crops to extend the fall grazing season with reference to liveweight gain, animal carrying capacity, and animal product quality.

At Mandan, ND, 4 scientists (Frank, Karn, Hofmann and Ries) are evaluating improved cool-season grasses in grazing systems, including the determination of forage intake, animal diet selection, and grazing preferences.

At Lincoln, NE, 2 scientists (Vogel and Moore) are evaluating smooth bromegrass and crested and intermediate wheatgrass germplasm in grazing trials. Blood serum mineral balance of animals grazing these grasses is being studied in cooperation with a researcher (Littledike) at the Animal Health Systems Research Unit at Clay Center. Grazing evaluation of strains and populations of switchgrass and big bluestem with improved forage quality attributes a planned.

At Woodward, OK, 3 scientists (Berg, Sims, White) are determining how efficiency of red meat production can be increased with improved forage genotypes and developing systems for complementary grazing of annual, perennial, and native forages

C) Future forage grass and pasture research needs:

The following listing of research needs was determined by majority rule of the participants of the workshop. They are listed in priority order in four priority groupings.

Priority I

1. Improve production and seasonal distribution of dry matter and nutrients:

   a) Increase on-farm genetic diversity by use of mixed species and cultivars, novel species, and multiple monocultures
   b) Identify management and genetic strategies that affect canopy dynamics and plant morphogenesis (growth rates, defoliation regimes, development rates, animal effects, carbon and nitrogen metabolism)
   c) Optimize nutrient input
   d) Modify phenological development of forage through defoliation management, growth regulators, genetics and wide hybridization, and minimization of reproductive tissue development
   e) Improve yield efficiency and seasonal distribution by breeding
   f) Nullify disease, insect, and nematode limitations

Priority II

2. Increase forage quality:

   a) Modify plant composition to improve digestibility and intake through breeding and management
   b) Define endophyte-host interaction effects in grasses
   c) Alter maturity effects on plant quality
   d) Nullify antiquality components
   e) Limit or control foliar diseases and insects

3. Improve persistence through breeding and management for:

   a) Insect, disease, and nematode control
   b) Soil limitations (pH, salinity, nutrients)
   c) Temperature and water stress
   d) Dormancy (seed and plant)
   e) Competition, grazing (defoliation)

4. Increase probability of successful stand establishment:

   a) Improve weed control (selective herbicides, management of defoliation-grazing)
   b) Exploit genetics and physiology of seedling vigor and morphology, seed quality, and seed dormancy
   c) Nullify allelopathic effects
   d) Assess and control diseases, insects, nematodes, and slugs
   e) Nullify drought, temperature, and soil stress

Priority III

5. Develop and refine methodology for:

   a) Germplasm evaluation and selection techniques
   b) Efficient plant breeding methods (conventional, biotechnology, apomixis, wide hybridization)
   c) Grazing animal productivity measurements
   d) Plant physiological processes
   e) Non-destructive plant productivity and forage quality assessment methods that will predict animal response.

6. Assess impact of forage/livestock systems on the environment:

   a) Surface and ground water quality
   b) Nutrient cycling (N, P)
   c) Pesticide movement
   d) Waste management
   e) Salinization
   f) Soil erosion
   g) Breed grass cultivars to meet specific environmental needs
   h) Global change (carbon source-sink relationships)
   i) Effect of nitrous oxide and methane

7. Improve water-use efficiency:

   a) Breed improved plants
   b) Alter rhizosphere characteristics
   c) Identify factors associated with water-use efficiency

8. Increase forage-based livestock production efficiency:

   a) Integrate livestock/crop production systems
   b) Improve grazing management, including supplementation
   c) Optimize interaction of animal species, breed, or type with forage resources
   d) Identify and manage limiting resources (risk management assessment and economics)
   e) Identify effects of production systems on animal product quality

Priority IV

9. Optimize seed production of forage and turf grasses:

   a) Improve seed quantity and quality through breeding and management
   b) Manipulate plant development (vegetative and reproductive)
   c) Develop residue management/utilization strategies
   d) Nullify biotic and abiotic stresses

10. Develop alternative uses for forage grasses:

   a) Low maintenance turf
   b) Conservation
   c) Reclamation
   d) Wildlife
   e) Energy/fiber/biomass production
   f) Byproducts/secondary metabolites
   g) Perennial grain crop

D) Strategy for meeting research needs:

Listed below are the locations where ARS has expertise available to address the research needs identified in section C above. Also listed are the additional expertise and recommended locations for that expertise needed to accomplish the research objective.

Research need no.	Where available	Additional expertise needed *	Recommended location(s)
Priority I			
1 Production/Distribution	Univ Pk Lexington Mandan Lincoln Logan Tifton Temple Woodward Gainesville Raleigh Booneville Brooksville El Reno Beckley Watkinsville Miss State	Genet/Cytogen-W Agron/Physiol-M Ecol/Management-UP	Lexington Logan Raleigh Univ Pk Temple
Priority II			
2 Forage Quality	Univ Pk Lexington Mandan Lincoln Logan Brooksville Tifton Woodward Corvallis Madison Raleigh Temple Booneville El Reno Beckley Watkinsville Miss State St Paul	Agron (Eval)-C Molec Biol-C Anim Nutr-W Anim Nutr-P Anim Sci-U	Univ Pk Lexington Lincoln Clay Cent. Temple Logan Beckley Univ Pk

3	Persistence	Univ Pk	Physiology-CP	Temple
		Temple	(Drought & Cold)	Logan
		Lexington		Mandan
		Mandan	Path/Dis Asses-C,W	Univ Pk
		Lincoln		Mandan
		Logan		Lincoln
		Tifton		Lexington
		College Sta	Entomol-C,P,U	Logan
		Woodward		Watkinsville
		Corvallis	Microbiol-P	?
		Gainesville	Weed Sci-M	Univ Pk
		Raleigh		Watkinsville
			Nematol-U	Beckley
				Miss State
4	Stand Establishment	Univ Pk	Physiol/Soil Sci-MP	Watkinsville
		Lexington		Miss State
		Mandan	Physiol/Manage-U	Raleigh
		Lincoln		Beckley
		Logan		Univ Pk
		Tifton		
		Temple		
		Woodward		
		Corvallis		
		Gainesville		
		Raleigh		
		Miss State		
		Booneville		
		El Reno		

Priority III

5	New Methodology	Univ Pk	Cytogenet-CW	Mandan
		Lexington		Woodward
		Mandan		
		Lincoln	Molec Biol-CWP	Lexington
		Logan		Corvallis
		Corvallis		Lincoln
		Tifton		Temple
		College Sta		
		Temple		
		Woodward		
		Gainesville		
		St Paul		
		Beckley		
		El Reno		
		Raleigh		
		Madison		

6	Environmental Impact	Univ Pk Lexington Beckley Mandan Lincoln Logan Corvallis Tifton College Sta Temple Woodward Gainesville Coshocton St Paul Sidney	Soil Sci/Nutr Cy-P Hydrology-M Ecology-U	Mandan Raleigh Brooksville Gainesville Watkinsville Beckley Brooksville
7	Water-use Efficiency	Mandan Lincoln Logan Univ Pk Tifton Temple Woodward Gainesville	Genetics/Physio-C Soil Sci/Physics-P Hydrology-M	Logan Logan Mandan El Reno Woodward
8	Forage/Livestock System	Univ Pk Mandan Lincoln Logan Tifton Woodward Brooksville Corvallis Raleigh Booneville Watkinsville El Reno	Anim Sci/Nutri-C Agron/An Sci-CWPMU (Graz Mgmt System) (Forage Eval)	Univ Pk Clay Center Raleigh Beckley Univ Pk Watkinsville Miss State Madison Mandan Corvallis

Priority IV

9	Seed Production	Corvallis Tifton College Sta Temple Woodward Lincoln	Breed/Genetics-C Entomol-W (midge)	Corvallis Lincoln

10	Alternative Uses	Univ Pk Lexington Mandan Lincoln Logan Corvallis Tifton College Sta Temple Woodward	None Identified

* Discipline group(s) from which the recommendation was made:

C = Cool Season Grasses
W = Warm Season Grasses
P = Physiology and Pathology
M = Pasture Management
U = Pasture Utilization

Note: Need to develop expertise in biotechnology and link with grass breeding programs consider forage breeding for far west - presently none west of Utah.

E) Appendix I:

Listed below by discipline group are the work sheets used to develop the the recommentations for additional expertise given in section D above:

Discipline Group: Cool Season Grass (Genetics)

Research need no.	Expertise available Y/N	Where available	Additional expertise needed	Recommended location(s)
1 (Production/Distribution)	Y	Univ. Pk. Lexington Mandan Lincoln Logan		
2 (Forage Quality)	Y	Univ. Pk. Lexington Mandan Lincoln Logan	Evaluation Molec. Biol. Breeder	Univ. Park Lexington & Lincoln Raleigh
3 (Persistence)	Y	Univ. Pk. Lexington Mandan Lincoln Logan	Physiology/ Drought Response Plant Path./ Disease Asses. Entomology	Logan Mandan Univ. Park, Mandan, & Lincoln Lexington Logan
4 (Stand Establishment)	Y	Univ. Pk. Lexington Mandan Lincoln Logan	NO	
5 (New Methodology)	Y	Univ. Pk. Lexington Mandan Lincoln Logan Corvallis	Cytogenetics Molec. Biol.	Mandan Lexington, Corvallis, Lincoln
6 (Environmental Impact)	Y	Univ. Pk. Lexington Mandan Lincoln Logan Corvallis	NO	

7	(Water-use Efficiency)	Y	Mandan Lincoln Logan Univ. Pk.	Genetics/ Physiology	Logan
8	(Forage/livestock system)	Y	Univ. Pk. Mandan Lincoln Logan	Animal Nutr./ Forage Quality	Univ. Park
				Forage Eval./ Grazing Mgt.	Corvallis
				Livestock Sys.	Clay Center
9	(Seed Production)	Y	Corvallis	Breeding/ Genetics	Corvallis
10	(Alternative Uses)	Y	Univ. Pk. Lexington Mandan Lincoln Logan Corvallis	NO	

Need to develop expertise in biotechnology and link with grass breeding programs consider forage breeding for far west - presently none west of Utah.

Discipline Group: Warm Season Grass (Genetics)

Research need no.	Expertise available Y/N	Where available	Additional expertise needed	Recommended location(s)
1 (Production/Distribution)	Y	Tifton Temple Woodward Lincoln Univ. Pk.	Genetic & Cytogenetics (Perennial) (Annual)	Midwest (Lexington) Lincoln
2 (Forage Quality)	Y	Tifton Woodward Lincoln Univ. Pk. Mandan Brooksville	Anim. Nutr. Breeder	Midwest (MARC) Temple Raleigh
3 (Persistence)	Y	Tifton College Sta. Woodward Lincoln Mandan	Pathology	Midwest (Lexington)
4 (Stand Establishment)	Y	Tifton Temple Woodward Lincoln Mandan Univ. Pk.	NO	
5 (New Methodology)	Y	Tifton College Sta. Temple Woodward Lincoln Univ. Park	Cytogentics Biotechnology	Woodward Temple
6 (Environmental Impact)	Y	Tifton College Sta. Temple Woodward Lincoln	NO	
7 (Water-use Efficiency	Y	Tifton Temple Woodward Lincoln Univ. Pk.	NO	

8	(Forage/Livestock System)	Y	Tifton Woodward Brooksville	Systems (4SY)	Clay Center
9	(Seed Production)	Y	Tifton College Sta. Temple Woodward Lincoln	Entomologist (seed midge)	Midwest (Lincoln)
10	(Alternative Uses)	Y	Tifton College Sta. Temple Woodward Lincoln	NO	

Discipline Group: Physiology and Pathology

Research need no.		Expertise available Y/N	Where available	Additional expertise needed	Recommended location(s)
1	(Production/Distribution)	Y	Gainesville Logan Mandan Raleigh Temple Tifton	Ecology, Physiol.	Several
2	(Forage Quality)	Y	Corvallis Logan Madison Mandan Raleigh Temple Tifton	Anim. Nutr.	Logan
3	(Persistence)	Y	Corvallis Gainesville Logan Mandan Raleigh Temple Tifton	Physiology (Drought Toler.) (Cold Tolerance) Entomology Pathology Microbiology	Mandan Logan & South.Plains Logan Mandan
4	(Stand Establishment)	Y	Corvallis Gainesville Logan Mandan Temple Tifton	Soil Sci/Physiol	Southeast
5	(New Methodology)	Y	Corvallis Gainesville Logan Madison Mandan Woodward Raleigh Temple Tifton Univ. Park	Biotechnology	Lexington Temple
6	(Environmental Impact)	Y	Corvallis Gainesville	Soil Sci. (Nutrient Cycle)	Mandan Raleigh

7	(Water-use Efficiency	Y	Gainesville Logan Mandan Temple	Soil Sci.	Logan Mandan
8	(Forage/Livestock System)	Y	Corvallis Logan Mandan Raleigh Tifton	Systems Analyst	Clay Center
9	(Seed Production)	Y	Corvallis Tifton	NO	
10	(Alternative Uses)	Y	Corvallis Logan Mandan Temple Tifton	NO	

Discipline Group: Pasture Management

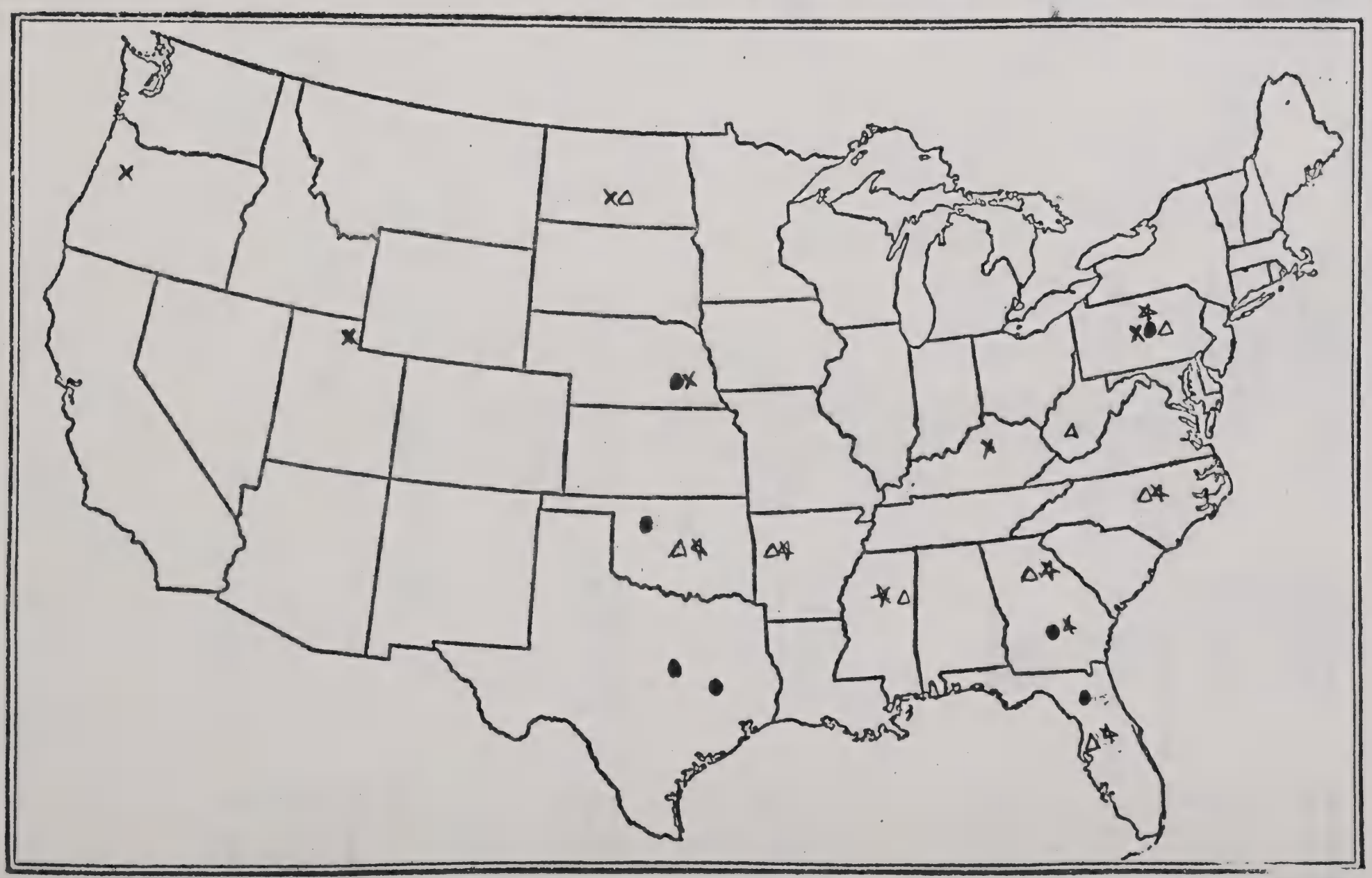
Research need no.	Expertise available Y/N	Where available	Additional expertise needed	Recommended location(s)
1 (Production/Distribution)	Y	Watkinsville Univ. Park Beckley Tifton El Reno Miss. State Booneville Brooksville Raleigh Mandan	Agronomist/ Physiologist	West
2 (Forage Quality)	Y	Booneville Brooksville El Reno Beckley Watkinsville Mississippi St. Mandan St. Paul Tifton Raleigh	NO	
3 (Persistence)	Y	Watkinsville Beckley Tifton Univ. Park El Reno Miss. State Booneville Brooksville Raleigh Mandan Woodward	Weed Sci.	Univ. Park Watkinsville
4 (Stand Establishment)	Y	Watkinsville Univ. Park Beckley Tifton El Reno Miss. State Booneville Brooksville Raleigh Mandan Woodward	Physiologist/ Soil Scie.	Watkinsville Miss. State
5 (New Methodology)	Y	St. Paul Beckley El Reno	NO	

6	(Environmental Impact)	Y	College Sta. Coshocton Beckley Univ. Park St. Paul Sidney Mandan	Hydrology/Soils (Nutrient Cycle)	Brooksville Mandan
7	(Water-use Efficiency	Y	Beckley Univ. Park Coshocton Mandan	Hydrologist Soil Physics Physiologist	Western U.S.
8	(Forage/Livestock System)	Y	Booneville Watkinsville Brooksville El Reno Mandan Tifton	Agron/Anim. Sci.	Univ.Pk Beckley Raleigh Clay Center
9	(Seed Production)	N/A	None identified	(See breeding discipline groups)	
10	(Alternative Uses)	Y	None identified	NO	

Discipline Group: Pasture Utilization

Research need no.		Expertise available Y/N	Where available	Additional expertise needed	Recommended location(s)
1	(Production/Distribution)	Y	Raleigh Brooksville Booneville Watkinsville Univ. Park El Reno Miss. State Mandan Woodward	Ecology/ Management	Raleigh Univ. Park
2	(Forage Quality)	Y	Raleigh Univ. Park Watkinsville Tifton El Reno Miss. State Mandan	Animal Sci	Beckley Univ. Park
3	(Persistence)	Y	Raleigh Univ. Park Watkinsville Tifton El Reno Miss. State Mandan	Entomology/ Nematology	Watkinsville Beckley Miss. St.
4	(Stand Establishment)	Y	Gainesville Miss. St. Boonesville El Reno Univ. Park Lincoln Mandan	Physiology/ Management	Raleigh Beckley Univ. Park
5	(New Methodology)	Y	Gainesville El Reno	NO	
6	(Environment Impact)	N	Not Available	Ecologist	Gainesville Watkinsville Beckley Brooksville
7	(Water-use Efficiency	Y	Univ. Park	Soil Scientist	El Reno

8	(Forage/Livestock System)	Y	Raleigh Beckley Univ. Park Watkinsville El Reno Booneville Brooksville Mandan Woodward Miss. State	Farm Management/ modular (NZ input needed) eco-physiologist	Raleigh Beckley Univ. Park Watkinsville Miss. St. Madison Mandan Clay Center
9	(Seed Production)	Y	N/A	NO	
10	(Alternative Uses)	Y	Univ. Park	NO	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Pasture Utilization
X Cool Season Grass Genetics
Warm Season Grass Genetics
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